DEPARTMENT OF COMMERCE DETROIT, MICH.

TECHNICAL NEWS BULLETIN
OF THE BUREAU OF STANDARDS

Subscription, 25 cents a year (U. S.), 40 cents a year (Foreign). Address "Superintendent of Documents, Washington, D. C."

Washington, April, 1927—No. 120

MEETING OF ADVISORY COMMITTEE ON CERAMICS

A meeting of the Advisory Committee on Ceramics was held at the bureau on March 30. The following attended the meeting:

E. C. Sullivan, Corning Glass Works.
H. S. Hower, Macbeth-Evans Glass Co.
A. E. Williams, Hartford Empire Co.
L. E. Barringer, General Electric Co.
G. H. Brown, Rutgers University.
Leslie Brown, Lenox (Inc.).
E. H. Weil, Vitreous Steel Products Co.
F. C. Davis, Gladding-McBean Terra Cotta Co.
R. H. Pass, Onondaga Pottery Co.
J. W. McBurney, Common Brick Manufacturers Association.
H. G. Wolfram, Porcelain Enamel & Manufacturing Co.
E. P. Poste, Chattanooga Stamping & Enameling Co.
B. T. Sweeley, Baltimore Enameling & Novelty Co.
R. D. Cooke, Benjamin Electric Co.
O. W. Renkert, Metropolitan Paving Brick Co.
F. B. Lysle, Eastern Clay Products Association.
W. S. Mayer, Mayer China Co.
C. E. Jackson, Warwick China Co.
F. H. Riddle, Champion Porcelain Co.
A. A. Weller, Homer-Laughlin China Co.
Stuart M. Phelps, American Refractories Institute.
A. C. Bleininger, chairman, Homer-Laughlin China Co.

This membership of the committee indicates a very excellent representation of the white-ware, enamel, and glass industries, but a rather poor representation of the heavy clay products and refractories groups. The agenda for the meeting, which was followed entirely, was as follows:

Call to order by the chairman, Prof. A. V. Bleininger.

Introductory remarks by the director, Dr. George K. Burgess.

General remarks on the work of the ceramic division, by P. H. Bates.

Physical properties of vitreous china bodies—specifications for vitrified china (A. N. Finn).

Commercial feldspars, their qualities and effects in vitreous and "semi-vitreous" white-ware bodies (G. W. Wray).

The work of the glass section (A. N. Finn).

The work of the refractories section—present and proposed studies of individual clays used in the manufacture of clay refractories (R. F. Geller).

Sagger clays—results of determinations of fundamental qualities (R. A. Heindl).

The work of the enameled metals section (W. N. Harrison).

The drying of clays—with particular reference to those used by the Bureau of Mines in their study of "the burning problems of industrial kilns" (W. H. Wadleigh).

The study of extrusion machines—the effect of various auger tips, spacers, and die tapers (P. C. Grunwell).

Structural properties of burned clay products (D. E. Parsons).

The work of the Columbus Station—English china clays; elasticity and thermal expansion of glazes; and properties of heavy clays (T. A. Klinefelter).

The work at Columbus on refractories (R. F. Geller).

General discussion by the committee of reports and suggestions for future work.

The brief talks given by the representatives of the bureau, together with discussions of these, extended the meeting from 10 a. m. until 6 p. m. At the same time the representatives of the glass and the enamel groups took the opportunity to meet with the chiefs of these two sections of the bureau and go over in

further detail the work of interest to them. The progress of the work, as evidenced by the reports given, was very satisfactory to the committee, and no marked deviations from the continuation of the present program were indicated.

The minutes of the meeting will be distributed to those who were in attendance. In the minutes will be given very briefly a résumé of the reports given as indicated above. Some copies of these will be available for distribution to those who are interested and address the bureau for them.

FIRE RESISTANCE OF HOLLOW TILE

The fire tests of hollow load-bearing wall tile have been completed, the last tests being of walls seasoned by accelerated methods to constant weight before testing.

The safe and economical use of hollow tile, as of other masonry materials, for load-bearing, party, and fire walls requires knowledge not only of the strength of walls under conditions of everyday use but also of the strength and fire resistance under conditions imposed by severe fires. Prior to the initiation of the work herein reported, only a few tests had been made. The Hollow Building Tile Association, recognizing the limitations that were being imposed on the use of the products of their members because of the lack of information on behavior under conditions of use, established in 1920 a research fellowship which has been continuous since that time. Several series of fire tests with compression and other auxiliary tests of individual tile have been completed.

Scope of the Work.—The initial part of the fire-resistance work consisted of tests of tile from 19 different plants, the tests being made by fire application on one side of piers 1 foot wide and 6 feet high. The main object was to determine the fire effects on the individual units. The results of this series of tests gave information which made possible the selection of a minimum number of plants for supplying tile, of the various types and common designs, for tests of large walls (11 by 16 feet) such that the full range in fire resistance of the product as manufactured would be developed. The latter series consisted of fire-endurance tests (and a few fire and water tests) of plastered and unplastered walls, tested unrestrained, restrained and loaded, the range in thickness being from 8 to 16 inches. Additional tests of smaller walls (4 by 4 feet) were added in order to include more types of tile and to bring out the maximum resistance period developed by the heavier walls. This series of tests was further augmented by tests of small walls built of tile embodying certain features promising increased fire resistance.

Auxiliary to the fire tests, compressive strength and absorption tests of all of the different kinds of tile were made, as also expansion and freezing tests, and chemical and microscopic examinations of typical kinds of tile and clays. Cooperation was also extended in the conduct of compressive and transverse tests of hollow-tile walls. Seventy such tests were made, the results of which were published in Bureau of Standards Technologic Paper No. 311. Cooperative work has also been undertaken recently in acoustical tests and in plaster-adhesion tests.

The second series of fire tests was made to determine the influence of certain factors, such as size of unit and effectiveness of plaster, and of certain changes which can be made in the manufacturing process.

Effect of Grog.—Ground burnt clay additions to three different kinds of clay of 0, 2½, 5, or 10 per cent by volume of grog content were used. The walls of tile with no grog or only small amounts withstood longer fire exposures than those built of tile having 5 or 10 per cent grog. A microscopic examination of fractures of tile containing grog showed minute cracks, probably from drying or burning shrinkage, radiating from the grog particles into the clay matrix. These fine cracks were apparently responsible for the difference in fire effects noted.

Combustible Filler.—Tile with combustible filler (sawdust) to the amount of 0, 5, 10, and 15 per cent were tested

It was found that additions of combustible filler of up to 15 per cent to clays, more especially to the dense burning clays, will increase fire resistance. Large amounts added to clays that normally give tile of low strength may decrease the strength to such an extent as to make the tile unsuitable for load-bearing walls.

Shell Thickness.—These tests did not show appreciable difference in fire effects with an increase of shell thickness over that normally used for standard tile, namely, ¾ to ⅞ inch. However, thicker shells, like finer grinding and increased pugging, give tile of greater compressive strength and hence greater residual strength of load-bearing walls after fire exposure.

Fillets.—It was found that moderate fillets of up to ¼ or ⅜ inch radius are desirable, but that larger fillets are not beneficial.

Hardness of Burning.—The tests showed that tile should be burned to a normal degree of maturity, but that hard-burned tile are more susceptible to fire damage. These, as well as other tests, particularly those in the first series, indicate that there is no advantage from the fire-resistance standpoint in underburning.

Effect of Plaster.—Numerous tests with fire exposures of one and one-half hours or longer duration show that, properly applied, gypsum plaster of acceptable grade, and also cement plaster with lime substitutions of 50 per cent or less by volume, will stay in place throughout fire exposures up to the fusion point of the plaster. These tests also show that many unplastered walls which would be damaged by short fire exposures would suffer only minor damage if plastered. Later tests of furred walls show that the use of furring and plaster will further decrease the susceptibility to damage of the structural part of the wall.

Effect of Size of Unit.—For these tests 8 by 12 by 12 inch tile were cut to 8 by 12 by 6 inch size and built adjacent to each other in the test walls. No difference in fire effects was observed. Other tests with the different standard types and sizes of tile gave similar results, except that units having one dimension small with reference to another dimension were likely to develop vertical cracks perpendicular to the long dimension.

Number of Cells.—With the larger number of cells there was no difference in the liability to loosening of the exposed shells, but where shells were loosened the damage, except with the more severe fires, did not extend beyond the web adjacent to the shell, confining the damage more nearly to the exposed surface of the wall, leaving a greater residual wall strength after fire exposures.

Change of Design.—An attempt to increase fire resistance involved the use of a double side shell, the outer one being as thin as possible and serving as a protection, the inner one being thicker and served to carry the load. Tests of tile of this design showed that any fire damage from moderate fires consisted mainly in loosening the outer shell so that it was confined to near the surface of the wall. In such cases repairs could be made by removing loosened shells and replastering.

The third series consisted of fire-endurance tests and fire and water tests of large walls, supplemented with a number of tests of walls 4 feet high in the small furnace.

Forty-six full walls of this series were subjected to tests in the large furnace. A number of these walls were divided into two sections, each 8 feet long and embodying variation, such as change of plaster or mortar in one section, so that in effect two tests were made simultaneously. On this basis 73 tests of large walls were made. Of these, 4 were subjected to fire and water tests. In addition, approximately the same number of small walls, 4 feet square, were subjected to fire tests.

Load-Carrying Ability.—As indicated by the tests the ability of tile walls to carry load under fire exposure is governed by the kind of clay used for the tile and the design of the units. A few 8-inch unplastered walls, which were built of lightweight tile, of very dense tile, or of heavier tile of comparatively low unit strength, failed under the applied working load or were damaged to

such extent as to make them unsafe after fire exposures of 25 minutes to 2 hours. All other walls carried the working load up to or beyond the useful limit, as determined by temperature transmission, for all periods up to 8 hours.

Fire Damage.—The fire damage varied greatly in amount, depending mainly upon the kind of clay used and upon the design of the units. Tile from some sources showed little effects after the fire exposure and units from others suffered material damage after relatively short fires. The fire damage to the individual units consisted mainly in the fracture of the webs holding the exposed shells. The damage rarely extended beyond the first longitudinal web except after long exposures.

Deflection.—The deflection of walls unrestrained at the top or vertical edges was away from the fire, being about 5 inches maximum at the top of 8-inch walls and 3 inches at the top of 12-inch walls. In cooling, all of the test walls returned to within 2 inches of their original positions. The deflection of restrained or loaded walls was toward the fire, being a maximum at the center of the wall. For 8-inch walls the movement at this point during the fire varied from ½ to 2 inches and in cooling they returned to within less than ½ from the original undeflected position. The amount of deflection decreased with increased wall thickness, being for 12-inch walls from ½ to 1 inch, with recovery to within ½ inch from the original position.

Temperature Transmission. — According to present specifications, an average temperature rise of not more than 139° C. (250° F.) is permitted under asbestos pads placed on the unexposed side of the wall when subjected to the standard fire exposure for durations equal to the fire-resistance period required. The periods given in the table are near the minimum obtained in the tests. The average periods developed in the tests for given wall thicknesses are from one-half to one hour longer than these values.

Fire-resistance periods of walls of load-bearing hollow tile when the resistance period is limited by the temperature rise on the unexposed side of the wall.

Thickness of wall (inches)	Number of units in wall thickness	Number of cells in wall thickness	Fire-resistance period	
			Unplastered	Plastered on both sides
			Hours	*Hours*
8	1	2	1½	2½
8	1	3	2	3
8 [1]	2	1		[2] 4½
8 [3]	2	2 or 3		5
12	1	3	3	4
12	2	3	4	5
12	2	4	5	7
12 [1]	2	2		[2] 6
16	2 or 3	4	8	10
16	2 or 3	6	10	12

[1] Brick faced.
[2] Plastered on one side.
[3] Furred one side; plastered both sides.

These periods refer to bearing or nonbearing partitions and walls in fire-resistive buildings. In nonfire-resistive buildings combustible members should not project more than 4 inches into the wall for 8 and 12 inch walls, and the ends in the wall should have not less than 4 inches of solid material all around them if the full fire resistance of the wall is to be developed.

ELASTICITY AND TRANSVERSE STRENGTH OF SAGGER CLAYS AT ELEVATED TEMPERATURES

A brief description of an apparatus designed and constructed for determining the modulus of elasticity and transverse strength, as well as plastic deformation at 1,000° C., of refractory clays appeared in the November, 1926, issue of the Technical News Bulletin.

Seventeen sagger clays have been tested for moduli of elasticity and rupture—(1) at room temperature; (2) at the temperature (ranging from 350 to 925° C.) at which saggers made from these clays failed in an air-quenching test; and (3) at 750° C. A wide variation was found between the moduli of

elasticity of the various clays. Determinations at room temperature gave values ranging from 889,000 to 9,430,000 lbs./in.^{2}.

The majority of the clays were found to have a higher modulus of elasticity or, in other words, were less easily deformed elastically when tested at 750° C. than when tested at room temperature. Only those clays which were comparatively weak at room temperature increased greatly in strength at 750° C. Two clays showed a marked decrease in strength at 750° C.

The data obtained indicate that an approximate direct relation exists between transverse strength and elasticity, and an inverse relation between porosity and elasticity.

It is believed that modulus of elasticity, thermal expansion, and transverse strength are the most important factors in determining the resistance of a sagger to thermal shock. An empirical formula employing these properties was developed which gives a factor indicating the resistance of a sagger to failure caused by thermal shock, as follows:

$$R=\frac{M}{Ee}$$

where

R=factor indicating relative resistance of a sagger to failure,

E=modulus of elasticity determined at 750° C.,

M=modulus of rupture,

e=coefficient of thermal expansion at the temperature of failure of the sagger.

Values of E and M, determined at room temperature, do not give a value for R which would correctly indicate the resistance of a sagger to failure due to thermal shock.

A paper giving a complete description of the apparatus used, together with the data obtained, will appear in an early issue of the Journal of the American Ceramic Society.

EXTRUSION MACHINE AUGER AND DIE INVESTIGATION

In the recent study of the extrusion machine the eastern Maryland brick clay, described in the Technical News Bulletin for November, 1926, has been employed exclusively.

For such a clay the best results were obtained by tempering with 25½ per cent total water and pugging two and one-half minutes in a wet pan.

The workability of this material was found to be little affected by repeated extrusion through a brick die. It is evident, however, that the flow pressure increased, incident with the decrease in moisture which always takes place as the clay is worked. It also appears that the unit output for single, double, or triple winged augers decreases as the length of the collective spacer between the tip of the auger and the mouth of the die or the length of the die increases.

The unit output for either of the three types of augers is slightly greater with a 4-inch collective spacer than with a 6-inch collective spacer, but the objectionable zigzagging and consequent cracking of the column that is present with a 4-inch collective spacer and a 6-inch die is entirely eliminated when a 6-inch collective spacer is used.

These results may be altered somewhat when experiments are made with a more or less plastic shale or clay.

From the data thus far obtained with this so-called medium plastic clay it appears that a single winged auger, a 6-inch brick die of one degree taper, and a 6-inch collective spacer form the most efficient combination both as to power consumption and as to quality of the column.

AN ELECTRICAL CALCINER FO GYPSUM

In the commercial calcination of gypsum the procedures followed by various manufacturers differ widely, particularly in regard to the temperature and time of calcination. While it has been believed for a long time that variations in these factors would vary the quality and properties of the product, very few attempts have been made to determine quantitatively the magnitude of these changes.

Three years ago the bureau undertook some investigations of this phase of gypsum technology, and the results have appeared at various times in the technical

press. The apparatus used in this work has recently been replaced by a larger and improved model, which appears to satisfy fully the requirements for such experimental work.

The apparatus consists of a drum, slowly revolved by an electric motor. Automatic valves are provided which allow the escape of steam as the material calcines, but which prevent the loss of the finely ground gypsum. The heating is done by four electrical resistance units which are inclosed in the drum. These units are so arranged that they may be connected in parallel, in series parallel, or two may be disconnected and the remaining two used in parallel. With these connections and with an exterior resistance in series with them a wide variation in power input may be obtained. The calciner has a capacity of 12 kilograms of raw gypsum, and this furnishes ample material for any ordinary investigations.

With this equipment a charge of 12 kilograms may be completely calcined in less than two hours, or the time may be lengthened as desired. The temperature may be brought to any point up to 200° C. at practically any rate and held there for any length of time. The flexibility and ease of control make this calciner especially suitable for investigations of the effect of the temperature and duration of calcination on the properties of gypsum.

OPERATING RESULTS OF THE CONSTANT TEMPERATURE HUMIDITY BOX FOR THE STORAGE OF CEMENT TEST SPECIMENS.

The constant temperature and humidity box for storing cement, described in the March Technical News Bulletin, has been in operation for over two months. For the past 55 days the box has been in continuous service.

The temperature does not vary more than 1° from 70° F. for the most severe operating conditions when the doors are being opened for the reception and the removal of specimens for observation. Under these conditions the humidity is a minimum of 90 per cent, with but very occasional drops below 93 per cent. During the periods when the doors are kept closed the temperature variation is $\pm\frac{1}{2}$° F.; the humidity 97 per cent or better. Neither the temperature nor the humidity can be determined any more accurately than as stated because of the comparatively low precision of the recording thermometers.

Some interesting observations were made upon the influence of the circulating air and water. The circulating water acts as a temperature stabilizer. When the water is not circulating the temperature is unstable, rising and falling periodically. The amplitude and range of this period is dependent upon the adjustment of the control and the rates of cooling and heating supplied by the refrigerator and heating element, respectively. The period ranged from 4 to 10 oscillations per hour and the amplitude from 2° to $\frac{1}{2}$°. The regularity rather than the magnitude emphasizes the oscillations. Changes of equal magnitude which occurred much more slowly and irregularly would, in most cases, be overlooked unless the charts were closely scrutinized.

With circulating water shut off but air being circulated, the humidity in 24 hours dropped from 97 to 68 per cent.

During these tests the box was kept closed continually. The apparatus required one hour in which to regain the normal humidity conditions in the box after the circulating water and air had been turned on. With the door open six minutes the humidity fell to 50 per cent, the humidity of the room.

It is advisable to use tungsten points for the control relay contacts. When first placed in service the silver points, apparently making physical contact, made no electrical contact, so that, without control, during one evening the temperature of the box rose to about 130° F. No trouble has been experienced since tungsten points have been put on the relay contacts.

STEAM CLEANING LIMESTONE BUILDINGS

In Technical News Bulletin No. 104, December, 1925, there was described a method which the Bureau of Standards had just developed for cleaning stone buildings by steam. Since this item was published the bureau, in cooperation with the Indiana Limestone Co., Bedford, Ind., has conducted a research on the

steam process for cleaning limestone buildings and has developed the method to a commercially successful stage.

This work was undertaken originally to find a method of cleaning which would not have the harmful effects of acid washes or sand blasting. The first known experiment in steam cleaning a building was made with English apparatus 20 years ago in New York City. From this beginning the idea has progressed until, with the invention of a light, flat spray nozzle employing high-pressure steam and water in combination, it is now possible to clean Indiana limestone buildings satisfactorily with no harm to the surface.

Several buildings located in Washington, D. C., Baltimore, Md., Rochester, N. Y., New York City, and Jersey City, N. J., were cleaned with steam during the development work. The largest and most recent job was the Salada Tea Co.'s building in Boston, Mass., where 33,000 square feet of wall was successfully cleaned under commercial conditions, using the nozzle designed at the bureau.

From the experience on the Salada job it is concluded that Indiana limestone buildings may be cleaned economically and satisfactorily by the use of high-pressure steam and water used in the newly developed flat nozzle. No data are available as to the other building materials. Arrangements are being made to supply the new nozzle through the Architects' Service Bureau of the Indiana Limestone Co., Bedford, Ind., to whom inquiries regarding the process may be directed.

BUILDING CONSTRUCTION STATISTICS AND ECONOMICS

The total contracts awarded for January and February, 1926 and 1927, in 36 Eastern States, reported by the F. W. Dodge Corporation, were $835,095,800 and $752,106,000, respectively. This is a decrease in 1927 of 9.8 per cent, largely due to the extraordinary high January total in 1926, as the total for February, 1927, was approximately equal to that of February, 1926.

Wholesale and retail prices of building materials and cost indexes of construction, which include the item of labor as well as material, changed but little from the closing months of last year.

Monthly tables of building-material prices as paid by contractors in about 50 cities are mailed to those interested early in each month. Application for this service should be made to the Division of Building and Housing, Department of Commerce, Washington, D. C.

RECOMMENDED BUILDING CODE REQUIREMENTS

The demand for the Building Code Committee's report on Recommended Building Code Requirements for Working Stresses in Building Materials, which was printed in December, 1926, quickly exhausted the Superintendent of Document's supply of 5,000 copies. The paper has been reprinted, and is again available at 10 cents per copy.

STANDARD STATE MECHANICS' LIEN ACT

During the past two months comments and criticisms of the tentative draft of the Standard State Mechanics' Lien Act have been received by the division of building and housing from more than 100 organizations and individuals to whom the draft was sent or whose attention had been called to its provisions. Mr. Wheeler, secretary of the committee, has been preparing these comments for consideration by the committee at a meeting which will be called in May, if not earlier.

ZONING AND CITY PLANNING

Four members of the Advisory Committee on Zoning and City Planning met at the Department of Commerce on January 22, 1927, to study the draft of the proposed Standard City Planning Enabling Act, which had been revised by Mr. Bettman, of the division of building and housing. It was approved for issuance with certain amendments which were later perfected. The document, comprising 80 mimeographed pages, was distributed to many city planning experts and others particularly interested in the subject. Copies are now available at the division of building and housing, and a reprint is being made to take care of a more general distribution.

The Standard State City Planning Enabling Act is issued for the information and guidance of States which are considering the adoption of city planning legislation, and covers (1) the making of the city plan and the organization and powers of the city planning commission, (2) control of subdivisions, (3) control of buildings in mapped streets, and (4) regional plan and planning commission. A number of State legislatures are now considering bills based on the act.

The division has continued its study of zoning progress in the United States, and is constantly adding to its list of zoned municipalities which are reported. Since the issue of the 1926 edition of Zoning Progress in the United States, in mimeographed form, 49 municipalities have been added, making the total number of 480 municipalities reported zoned up to the present time.

STANDARDIZATION OF HIGHWAY SIGNS AND SIGNALS

Standardization of street, sign, and signal markings was one of the chief problems discussed at the recent annual convention of the American Engineering Council. The committee on street and highway safety is working on the problem of drafting a system of markings, which the council will seek to introduce throughout the country. The work is in line with recommendations of the Department of Commerce's safety conference and is expected to be an important step in the campaign to reduce the dangers of highway travel. The council hopes to devise a system that will make all street and highway markings intelligible at a glance to motorists from all parts of the country, and to eliminate many of the unnecessary markings now found on the roads.

SIMPLIFICATION OF AUTOMOTIVE INDUSTRY

General conferences between the Bureau of Standards, manufacturers, and users of spark plugs, oversized piston rings, brake lining, and taper roller bearings were held in Detroit on February 2 and 3. These conferences approved the standards which had been submitted as tentative Simplified Practice Recommendations by the Society of Automotive Engineers. At the present time all manufacturers, distributers, and users are being asked to submit their signed acceptances of these recommendations. Cooperation on the part of all interests will bring about more general adherence to the approved standards and should result in benefits to all concerned.

SIMPLIFICATION AND THE SPARE PARTS PROBLEM

In a recent statement R. M. Hudson, chief of the division of simplified practice, says:

Too much individuality in sizes, dimensions, etc., of wearing parts forces the equipment user either to carry a large stock of spare parts or wait until he can secure the needed replacements from the original equipment maker.

In the first case, the user may regard his spare-parts inventory and the cost of carrying it as an insurance against heavy "breakdown" or "out-of-service" costs. Nevertheless, the greater the diversity in his equipment—that is, shop machinery, cranes, electric motors, locmotives, motor trucks, etc.—the greater the cost to him of such insurance.

If the equipment user does not maintain a full spare-parts stock, but depends, in an emergency, on the equipment maker for quick delivery, there is the risk that the latter may not have the parts in stock, and consequently a delay in delivery may occur that increases the "out-of-service" cost to the equipment user. To obviate this difficulty, the user sometimes makes the necessary repairs with his own facilities or with the aid of local job shops.

This procedure results in a diversion of spare-parts business from the original equipment maker, and this diversion, plus the relatively high cost of manufacturing noncurrent parts a few at a time, tends to raise the cost to the user to a point where he is unwilling to pay the manufacturer's price, and in such cases he will try to find some cheaper way out, say, by making the repairs himself.

Equipment manufacturers sometimes say that competition prevents a fair profit on the original sale and that the real profits are in the sale of repair or replacement parts. Accurate cost accounting is likely to show there is little, if any, profit in spares when made "as and when" wanted. Mass production of spares is as logical and economical as mass production of original equipment. Both are based on simplification and standardization of product.

When spares are made in quantity proportionate to the rate of their demand, costs are lowered, adequate stocks strategically located are possible, service of supply is improved, turnover assured, and consequently the equipment

maker is likely to get more nearly 100 per cent of the replacement business on his product. Some may not now be getting 50 per cent of the spare-parts business on their own product.

Capital tied up in inventory earns no direct dividends. Manufacturing spare parts on a "hand-to-mouth" basis yields little, if any, profit. Between these extremes is the happy medium of manufacturing the spares in a quantity giving the lowest consistent cost, and controlling the stock on hand by varying the frequency of the issuance of the shop orders (to make that "economical" quantity) according to the rate of demand. In other words, with demand increasing, orders for this constant quantity are placed close together; with demand decreasing, the interval between shop orders is engthened.

The distributer or the purchasing agent can use this same method of ordering "the most economical quantity to buy" with greater or lesser frequency as the demand warrants, and thus escape some of the disadvantages he encounters in "hand-to-mouth" buying.

The higher the degree of standardization in the renewable parts and the fewer the variations in size, dimension, etc., the lower the cost to manufacture, stock, distribute, or purchase spare parts; and, coincidentally, the lower the "out-of-service" cost to the equipment user when breakdowns occur. The first step is for the equipment manufacturer to standardize the renewable parts of his product, beginning with those having the highest frequency of replacement.

SIMPLIFICATION OF HOSPITAL EQUIPMENT

The American Hospital Association has appointed a Committee on Standardization and Simplification of Equipment and Supplies, with the view of enabling hospitals to economize and take advantage of the work which the division of simplified practice is carrying on with various manufacturing groups. The hospital field covers some 7,000 hospitals in the United States and Canada. There is a building program now under way of over $300,000,000. Many millions are spent in the maintenance and replacement of equipment. The hospital individually is a retail consumer, but in the aggregate the field represents a large volume of business. The individual institutions are frequently isolated and would be greatly helped if this committee could formulate certain appropriate standards in equipment which they could buy with confidence. The cost of hospital building is abnormally high, because of the tradition that stock articles will not serve as well as something especially designed for hospital purposes. The chairman of the committee has suggested a number of items which might be simplified to advantage. The members of the committee will be glad to meet with any of the manufacturing groups affected by the suggested simplification.

The division of simplified practice has suggested that it might be to the advantage of other groups if they could appoint a committee on standardization and simplification to cooperate with the Department of Commerce in the development of simplified practice recommendations of benefit to their own industry.

SIMPLIFICATION OF MILK AND CREAM BOTTLES AND CAPS

The Joint Standing Committee on Simplification of Milk and Cream Bottles met at the Hotel Astor, New York, N. Y., on February 8 to reconsider the action taken on September 8 with regard to over-all height and body diameter of the half-pint bottle. After some discussion regarding diameters and weights, a revised recommendation was adopted, as follows: "In accordance with the unanimous action of the joint conference of manufacturers, distributers, and users of milk bottles, and further amended by the joint standing committee at its meetings in New York City on September 8, 1926, and February 8, 1927, the United States Department of Commerce, through the Bureau of Standards, recommends that in respect to bottles used in the sale of milk and cream the quarter-pint size be eliminated." Also definite sizes, capacities, and dimensions of the quart, pint, and one-half pint bottles were recommended. One size of cap was considered sufficient for all requirements. These revised recommendations went into effect March 1, 1927, subject to regular annual revision by the joint conference.

ULTRA-VIOLET TRANSMISSION OF CELLULOSE SUBSTITUTES FOR GLASS

There has been a great deal of activity recently in promoting the use of a cellulose product as a substitute for window

glass in henhouses. The bureau has received many inquiries on this subject from individuals and agricultural colleges, and therefore conducted some additional tests on the light transmission of this material.

The results of these tests verify the former measurements in showing that the fresh cellulose material is more transparent to ultra-violet light than window glass. However, even if the material is exposed to ultra-violet radiation for so short a time that the color developed in the cellulose is barely perceptible to the eye, the ultra-violet transmission is reduced 25 to 50 per cent.

This discoloration may not progress rapidly in sunlight, but it should be remembered that after the material has become perceptibly tinged a brownish color it is no better than window glass for transmitting the short ultra-violet rays of sunlight—a conclusion reached from similar tests made over a year ago.

A WET-RUB TESTER FOR PAPER

In connection with the recent investigation of the wearing quality of paper currency conducted by the Bureau of Efficiency, the Bureau of Standards, and the paper manufacturers, it was necessary to find out how the currency paper stands wear when wet. This property of paper is usually judged by rubbing the paper with a wet finger and noting the resistance of the surface of the paper to disintegration. It is obvious that if many tests of this kind were to be carried on the work would soon develop into a finger endurance test rather than tests of paper. Furthermore, a reproducible numerical value is highly desirable in research of this nature. Such a test is of importance in the case of most surface-treated papers, such as blue-print, map, and ledger papers. Hence the testing device which has been developed at the Bureau of Standards for this purpose may be of considerable general interest.

The apparatus consists of (1) a means of clamping the specimen of paper over a smooth hard surface; (2) a power-driven rubber friction surface or mechanical finger maintained under constant pressure; (3) a means of keeping the surface of the paper wet while being tested; (4) an automatic counter to record the number of "double rubs" required to wear a hole through the paper, the apparatus being so designed that the tester is stopped as soon as the hole is worn through.

The development of this testing device is another example of the substitution of measurement for guesswork in the study and improvement of materials and processes at the bureau. An article fully describing the apparatus was published in Paper Trade Journal, Vol. 84, No. 2, pp. 45–46 (January 13, 1927).

PAPER FROM WORN-OUT PAPER MONEY

Having succeeded in producing in its experimental paper mill an improved quality of paper for making the Government paper money, the bureau has reversed the process and produced a good quality of paper from the paper money after it has served its useful life. This work is a part of the cooperative investigation by the Bureau of Engraving and Printing, the Bureau of Efficiency, and the Bureau of Standards to effect economy in Government currency expenditures.

The worn-out paper currency returned to the Treasury Department for redemption, together with a small proportion of spoiled paper and trimmings from the currency printing processes, amounts to approximately 4 tons daily. At the present time this material is macerated at the Bureau of Engraving and Printing and is sold in the form of pulp containing some 70 per cent of water and practically all the ink. No attempt is made to clean the pulp, the process being carried only far enough to comply with the requirements for protection against unlawful use of the waste paper; that is, that it be entirely defibered so that no printed characters can be distinguished and that all distinctive features of the paper itself be removed. In this form the pulp is suitable for coarse paper products only, such as certain grades of boards, owing to its large content of impurities, which occur partly in the form of lumps. For this reason the price re-

ceived is so low that, according to a survey of the situation made by the Bureau of Efficiency, the maceration of the material is costing annually from $15,000 to $18,000. As the original paper is composed of the highest grade linen and cotton rag fibers, a clean pulp produced from the waste paper should have a ready market for fine writing and printing papers at a considerably increased price. It is estimated that by so improving the product the present loss can be turned to a profit amounting possibly to $50,000.

The material presents unusual resistance to the ordinary deinking treatments owing to the hardness and toughness of the paper, the large amount of ink present, and the resistant quality of the ink. It was found possible, however, to completely deink and otherwise quite thoroughly clean it with semicommercial machinery consisting of a duster, a rotary digester, and a beater equipped with a drum washer. The paper produced from the pulp compared quite favorably with good grades of fine writing and printing papers. As is to be expected, considering the wear to which the paper money is subjected and the weakening effect of the various deinking and defibering processes, a large proportion of the original strength of the fibers is lost. The recovered fiber paper, however, is sufficiently strong for the purpose mentioned, being somewhat stronger than that made from new sulphite fiber and as strong as some grades of rag fiber papers made from the lower grades of rags.

The results obtained are considered so promising that it is planned to purchase the additional commercial equipment for use in the recovery plant of the Bureau of Engraving and Printing required to produce a clean pulp and to dewater it more thoroughly so as to lower the transportation cost of the product.

TANNING WITH QUEBRACHO

In connection with the preparation of standard leather samples for use in researches on acid in leather, interesting observations have been made regarding the nature of a straight quebracho tannage. Seven 50 to 55 pound steer hides were used which were delimed with a commercial enzyme bate until neutral to phenolphthalein. The hides were then introduced into liquors made from ordinary solid quebracho of extract of 0.6 per cent tannin content. The concentration of the liquors was gradually increased until, after 25 days, it reached 4 per cent, between which value and 5 per cent it was maintained for 25 more days. The tannage throughout was allowed to proceed in a natural manner without the addition of any acids or acid-forming materials. At the conclusion of the tannage (50 days) the leather was washed, oiled, dried, sammied, rolled, and dried again. The physical appearance of the leather seemed satisfactory with respect to thickness, firmness, and color. The average yield was 60 per cent.

Observations of the hydrogen-ion concentration of the liquors showed that the original solution of analytical strength had a pH value of 4.7. Three days after the hides were introduced the pH value had increased to 5.8, at which figure it remained throughout the 50-day period. As was to be expected, the finished leather gave a decided alkaline reaction, by the Proctor and Searle method.

A sample of the leather was removed from the liquors after 30 days, washed, oiled, and dried. The analysis of this sample gave the following results:

	Per cent
Water-soluble material	18. 13
Hide substance	46. 10
Grease (petroleum-ether extract)	3. 55
Moisture	8. 75
Insoluble ash	. 19
Combined tannin (by difference)	23. 28
Degree of tannage	50. 50
Total ash	. 27

As reflected by the above analysis and the physical appearance of the leather as regards plumpness and fiber structure, the removal of the leather at this point and the finishing of it into sole leather by extracting would seem to be a likely possibility. This suggests a line of approach in shortening the time of tannage for sole leather by the usual use of a preliminary "sweet-liquor" tannage.

OIL ON RAYON KNITTING YARNS

The textile section of the bureau has been studying one phase of the problem involved in the use of oil on rayon knitting yarns. Oil as a softening agent is an important factor in knitting rayon. Rayon fiber has a tendency toward stiffness or wiriness, so that a softening agent is necessary in producing balanced, uniformly constructed stitches. It has been noted, for example, that when a strand of unoiled rayon yarn is drawn over a sharp angular projection the cylindrical shape of the yarn is flattened and its filaments separate. This may result in broken filaments, which present a nappy or fuzzy appearance. A similar strand of the yarn when oiled becomes so flexible and pliable that it retains its form and appearance under stress.

The use of oil, however, presents several aspects which must be considered: (1) The relative value of the oil as a softener, (2) its cost, and (3) its removability. These factors were not considered specifically in the present investigation, but may later be made the subject of exhaustive studies. One phase of the cost, however, is a controlling factor in fixing a standard percentage of oil. This is the difference in price of rayon and oil; hence the desirability of minimizing the oil content. This is particularly important from the standpoint of the majority of the hosiery manufacturers, for they buy the oiled rayon, and any excess of oil beyond that required for good knitting is an economic waste.

Early in the consideration of the problem of oil in rayon it was found that a wide range of percentages was in use. The National Association of Hosiery and Underwear Manufacturers was receiving an increasingly large number of inquiries on this subject. It was therefore considered desirable, since the full study of oil in rayon would require too long a time, to meet the present needs of the hosiery manufacturers by studying the practice throughout the industry and from the collated data to fix a standard maximum percentage of oil for use on rayon.

Accordingly, in response to a request for data and samples, 26 manufacturers generously cooperated by sending samples of rayon as used in their knitting departments and statements as to the percentage which each believed, from his experience, would produce satisfactory results. Tests for oil content were made on all these samples, and, in addition, the results on 26 samples submitted previously in connection with individual research problems were considered. A collation of these data showed the following:

	Per cent
Average of results from 26 research problems	6.4
Average of results from 23 manufacturers' samples	5.3
Average of all test results	5.9
Average of figures suggested by manufacturers	5.4

It is therefore proposed that the percentage of oil for rayon yarns to be used for knitting be fixed at 6 per cent maximum, based on the weight of the conditioned sample.

CAST IRON FOR ENAMELING PURPOSES

In the study of cast iron for enameling purposes some laboratory results recently have been obtained which appear to warrant further investigation on a larger scale. One set of results indicates that the particular firing treatment for the ground coat which is conducive to fewest blisters with an iron of a given history may differ from that conducive to fewest blisters with an iron of a different history. Thus of two irons, one produced fewest blisters when the ground coat was fired for five minutes at its maturing temperature, while another produced fewest blisters when the ground coat was fired for seven and one-half minutes. Although several irons of different history have been studied in the laboratory in this way, these observations should be verified in large scale work before being considered as final.

In addition to these experiments, another feature has been investigated in a laboratory scale, namely, that of preheating each piece before firing. Whatever the source of the blistering-producing gas may be, preheating apparently gives a chance for the source to respond to the stimulus of heat and evolve gas at

a temperature which is below the fusion point of the enamel. The gas so evolved is allowed to escape instead of being entrapped by the fused enamel, after which the enamel is matured in another furnace at a higher temperature. In practice a continuous process furnace might be used efficiently to obtain the effects of preheating. The laboratory results indicate that this feature is well worth full investigation, including its use in regular production.

RADIO SIGNAL TRANSMISSIONS OF STANDARD FREQUENCY, APRIL TO OCTOBER

The Bureau of Standards announces a new schedule of radio signals of standard frequencies for use by the public in standardizing frequency meters (wave meters) and transmitting and receiving apparatus. The signals are transmitted from the bureau's station WWV, Washington, D. C. It is to be noted that a number of the individual frequencies differ somewhat from those used in previous transmissions.

The transmissions are by continuous-wave radiotelegraphy. The signals have a slight modulation of high pitch which aids in their identification. A complete frequency transmission includes a "general call" and "standard frequency signal" and "announcements." The "general call" is given at the beginning of the eight-minute period and continues for about two minutes. This includes a statement of the frequency. The "standard frequency signal" is a series of very long dashes with the call letter (WWV) intervening. This signal continues for about four minutes. The "announcements" are on the same frequency as the "standard frequency signal" just transmitted and contain a statement of the frequency. An announcement of the next frequency to be transmitted is then given. There is then a four-minute interval while the transmitting set is adjusted for the next frequency.

The signals can be heard and utilized by stations equipped for continuous-wave reception at distances up to about 500 to 1,000 miles from the transmitting station. Information on how to receive and utilize the signals is given in Bureau of Standards Letter Circular No. 171, which may be obtained by applying to the Bureau of Standards, Washington, D. C. Even though only a few frequency points are received, persons can obtain as complete a frequency meter calibration as desired by the method of generator harmonics, information on which is given in the letter circular. The schedule of standard frequency signals is as follows:

Schedule of frequencies in kilocycles

[Approximate wave lengths in meters in parentheses]

Eastern standard time	Apr. 20	May 20	June 20	July 20	Aug. 22	Sept. 20	Oct. 20
10 to 10.08 p. m.	550 (545)	1,500 (200)	3,000 (100)	125 (2,400)	250 (1,199)	3,000 (100)	550 (545)
10.12 to 10.20 p. m.	630 (476)	1,650 (182)	3,300 (91)	140 (2,142)	283.3 (1,058)	3,300 (91)	633.3 (473)
10.24 to 10.32 p. m.	730 (411)	1,825 (164)	3,600 (83)	160 (1,874)	320 (937)	3,600 (83)	733.3 (409)
10.36 to 10.44 p. m.	850 (353)	2,025 (148)	4,000 (75)	180 (1,666)	363.7 (825)	4,000 (75)	850 (353)
10.48 to 10.56 p. m.	980 (306)	2,225 (135)	4,400 (68)	206.3 (1,454)	410 (731)	4,400 (68)	975 (308)
11 to 11.08 p. m.	1,130 (265)	2,450 (122)	4,900 (61)	233.3 (1,285)	466.7 (643)	4,900 (61)	1,125 (266)
11.12 to 11.20 p. m.	1,300 (231)	2,700 (111)	5,400 (56)	266.7 (1,123)	525 (571)	5,400 (56)	1,300 (231)
11.24 to 11.32 p. m.	1,500 (200)	3,000 (100)	6,000 (50)	300 (999)	600 (500)	6,000 (50)	1,500 (200)

NEW PUBLICATIONS

Additions to Supplementary List of Publications of the Bureau of Standards (beginning July 1, 1926).

Scientific Papers [1]

S540. Measurement of surface tension; N. Ernest Dorsey. Price, 15 cents.

S543. Linkage-current diagram for representing magneto operation; F. B. Silsbee and D. W. Randolph. Price, 20 cents.

S544. Effect of eddy currents in a core consisting of circular wires; Chester Snow. Price, 10 cents.

Technologic Papers [1]

T334. Relationships between the Rockwell and Brinell numbers; S. N. Petrenko. Price, 15 cents.

Circulars [1]

C319. Alphabetical index and numerical list of United States Government Master Specifications, promulgated by the Federal Specifications Board. (Available free upon request to Superintendent of Documents or Bureau of Standards.)

C320. Puncture-sealing compounds for pneumatic tires. Price, 5 cents.

C321. United States Government master specification for cement, masonry. Price, 5 cents.

C322. United States Government master specification for integral waterproofing material, water-repellent type (for use with Portland cement mortar or concrete). Price, 5 cents.

Simplified Practice Recommendations [1]

R52. Staple vitreous china plumbing fixtures. Price, 5 cents.

R55. Tinware, galvanized and japanned ware. Price, 5 cents.

R57. Wrought-iron and wrought-steel pipe valves and fittings. Price, 5 cents.

Technical News Bulletin [1]

TNB120. Technical News Bulletin, April, 1927.

OUTSIDE PUBLICATIONS [2]

Suggested program for the investigation of the fatigue resistance of welds. H. L. Whittemore; Journal American Welding Society, Vol. 6, No. 1, p. 21; January, 1927.

Test of an arc welded plate girder by the American Bridge Co. and the U. S. Bureau of Standards. H. L. Whittemore; Journal American Welding Society, Vol. 6, No. 1, p. 42; January, 1927.

Discussion of Templin's paper on effect of size and shape of test specimens on tensile properties of thin sheet metal. H. L. Whittemore; Proceedings American Society for Testing Materials, Vol. 26, Part II, p. 401; 1926.

Discussion of Werring's paper on impact testing of insulating materials. H. L. Whittemore; Proceedings American Society for Testing Materials, Vol. 26, Part II, p. 653; 1926.

Testing gas welds. H. L. Whittemore; Power, Vol. 65, No. 6, p. 211; Feb. 8, 1927.

Discussion of German's paper on standardization of Brinell hardness test. H. L. Whittemore, L. B. Tuckerman, and S. N. Petrenko; Transactions American Society for Steel Treating, Vol. XI, No. 1, p. 67; January, 1927.

Compressive strength and deformation of structural steel and cast-iron shapes at temperatures up to 950° C. S. H. Ingberg and P. D. Sale; Proceedings American Society for Testing Materials, Vol. 26, Part II, p. 33; 1926.

Rough turning with particular reference to the steel cut. H. J. French and T. G. Digges; Mechanical Engineering, Vol. 49, p. 339; 1927.

The selection of dental materials. Wilmer Souder; Journal American Dental Association; Vol. XIV, No. 2, p. 189; February, 1927.

Measurement of the gloss of paints by the Ingersoll glarimeter. E. F. Hickson; American Paint and Varnish Manufacturers Association; Circular No. 307; April, 1927.

[1] Send orders for publications under this heading, with remittance, only to Superintendent of Documents Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States); 40 cents (foreign).

[2] "Outside publications" are not for distribution or sale.

Effects of composition on the properties of ground coat enamels for sheet steel. W. N. Harrison and H. G. Wolfram; Journal American Ceramic Society; Vol. 10, No. 3; March, 1927.

The holding power of wood screws. I. J. Fairchild; Industry Illustrated, p. 19; February 15, 1927.

Fuel requirements for automotive engine starting. C. S. Cragoe and J. O. Eisinger; Journal Society of Automotive Engineers; Vol. XX, No. 3, p. 353; March, 1927.

The alternating behavior of fatty acids added to rubber compounds. W. H. Smith and C. E. Boone; Industrial and Engineering Chemistry; Vol. 19, No. 3, p. 398; March, 1927.

The structure of the La II spectrum. W. F. Meggers; Journal Optical Society of America and Review of Scientific Instruments; Vol. 14, p. 191; March, 1927.

Excitation of spectra by atomic hydrogen. F. L. Mohler; Physical Review; Vol. 29, p. 419; 1927.

The compensation of distortion in objectives for airplane photography. I. C. Gardner and A. H. Bennett, Journal Optical Society of America and Review of Scientific Instruments; Vol. 14, No. 3, p. 245; March, 1927.

The distortion of some typical photographic objectives. A. H. Bennett; Journal Optical Society of America and Review of Scientific Instruments; Vol. 14, No. 3, p. 235; March, 1927.

U. S. GOVERNMENT PRINTING OFFICE: 1927